behaviour of argon above the critical point is important. There is no single fluid phase but two distinct states of matter even though there is no visible discontinuity.

Commenting on the models of Dr. Egelstaff and Dr. Wilson, Prof. Bernal suggested that the presence of globules could be detected by the use of small-angle scatter and an estimate of their size obtained from viscosity measurements.

Turning next to alloys, Prof. Bernal put forward the idea that they could be considered as emulsions and cited as evidence the presence of the γ-phase in alloys of copper, silver or gold with zinc. In this phase the atoms are distributed at random over the lattice sites. However, the electron compound found in the gold–tin alloy system could be the cause of the structure observed in the X-ray diffraction patterns.

B. R. ORTON

RADIOACTIVE CHEMICALS, LABELLED COMPOUNDS AND RADIATION SOURCES

FOR most purposes, particularly in engineering and radiotherapy, where the radiological properties of radioisotopes are of paramount importance, it is generally sufficient to refer to the tabulated physical data given in Part 1 of *The Radiochemical Manual* for a suitable choice of radioactive material. However, in the case of radioactive tracers for use in the biological sciences, chemical technology and related fields, the purity, chemical stability and the characteristic behaviour of the isotopes as radioactive chemicals are often the decisive factors, and for these Part 2 of the *Manual* *, which has recently been published and which deals with the chemical aspects of radioactive materials, must be consulted.

The range of radioactive chemicals is very extensive, and Part 2 has therefore been limited to a number of articles on selected topics likely to be useful to users of radioactive tracers. The examples referred to are drawn largely from the practical experience of the scientific staff at the Radiochemical Centre at Amersham. The contents of Part 2 consist of three sections, dealing with the sources of radioactive chemicals, some characteristic features of the chemicals, and notes on labelled compounds of the elements carbon, hydrogen, sulphur, phosphorus, iodine and chlorine.

The first section contains four chapters in which the distinctive features which affect the manufacture of radioactive reagents are outlined. Radiological protection and remote handling frequently limit the types of chemical manipulation which can be carried out. The half-life of the isotope is the important factor in the organization of supply and distribution, and the chemical scale of manufacture which rarely exceeds one gram is a unique feature. The distinction between primary isotopes and labelled compounds is clearly drawn and the various methods of preparation are explained. Isotopic labelling and its wider implications, the synthesis of labelled compounds by chemical and biological methods and some of the unresolved problems such as the isotopic labelling of natural products by biosynthesis, are also discussed.

Chapters 5–7, which form the second section, are concerned with the concepts of purity and its determination, instability, and the behaviour of minute quantities and dilute solutions of radioactive chemicals. The final six chapters in the third section refer individually to compounds of each of the six elements which are most commonly concerned in tracer experiments. Carbon-14, which emits only β-particles, is produced by means of a reactor in adequate quantities and at high specific activity, and, since it has a half-life of 5,760 years, it is a most favourable tracer isotope. It has been used for the intensive study of biochemical processes and has now virtually displaced the stable isotope carbon-13 and the short-lived (20 min) radioactive isotope carbon-11. Tritium-labelled compounds are now second in importance to carbon-14 compounds in biochemical tracer work, but tritium is not used as a hydrogen tracer but as an accessory tracer for a carbon atom or a molecule or a molecular fragment. Tritium is available in quantity and high specific activity (up to 29 c./m.amp) and its half-life of 12·3 years is conveniently long.

Sulphur-35 is the only practicable label for sulphur atoms. Its half-life is 87·2 days, and although it can be produced by direct neutron irradiation, it is better extracted as sulphate at high specific activity from neutron-irradiated potassium chloride. The main groups of chemical in which sulphur-35-labelled compounds are of interest are listed in the *Manual*. Phosphorus-32 is relatively easy to prepare. Its half-life is 14·2 days and its main applications are in inorganic fertilizers, nerve gases, systemic insecticides, and plasticizers. Iodine-131 is in abundant supply from irradiated tellurium or from fission products, but its short half-life prevents stock-holding of iodine-labelled compounds. Other isotopes of iodine, iodine-132, iodine-125 and iodine-124, are also available. Chlorine-36 has a long half-life of $3 \cdot 03 \times 10^5$ years and is a pure β-emitter of medium energy. Its production is expensive and its specific activity is low, less than 4 mc./m.amp. Chlorine, however, is an important industrial chemical and therefore chlorine-36 has valuable applications. It is also in many ways an ideal radio-isotope for use in the teaching of practical chemistry.

Part 2 of the *Manual* concludes with thirteen tables of synthetic routes to labelled compounds, a glossary of terms used, and numerous references to published work relating to the topics discussed and the tables. For details of the products, radioactive chemicals and radioactive sources, and services provided by the Radiochemical Centre the reader is referred to the catalogue, *Radioactive Products* †, available on request from the Centre.

S. WEINTROUB

* *The Radiochemical Manual*. Part 2: *Radioactive Chemicals*. Pp. v+78. (Amersham: The Radiochemical Centre, 1963.) 25*s*.

† *Radioactive Products: Radioisotopes, Labelled Compounds, and Radiation Sources*. Pp. 119. (Amersham: The Radiochemical Centre, 1962.)

RESEARCH INTO TECHNICAL EDUCATION

THE report of a working party, with Prof. A. V. Judges as chairman, set up at the second session of a conference on June 6, 1961, presided over by Dr. Dunsheath, and attended by representatives of the University of London, the Regional Advisory Council for Technological Education (London and Home Counties), local authorities, technical colleges and research institutions, has now been published under the title *Research into Technical Education* *. The working party was charged, *inter alia*, with considering priorities in research in this field and, apart from the specific proposals for research which are detailed, the report gives in its introduction an admirable survey of the present position and of the

* *Research into Technical Education: Report of a Working Party*. Pp. 34. (London: The Regional Advisory Council for Technological Education. London and Home Counties, 1963.) 5*s*.

several authorities and institutions that are already active. Appended to the report, moreover, are notes on relevant activities of the National Foundation for Educational Research and the British Association of Commercial and Industrial Education, details of projects already in progress in the London colleges, of the two educational research projects in the Department of Mathematics at the Hatfield College of Technology and of the Nuffield research projects at the Birmingham College of Advanced Technology and at Brunel College.

Although the working party does not lose sight of its main concern—the technical colleges—this general survey is of considerably wider interest and the comments made are probably valid over a fairly wide field of secondary and of higher education. More research is obviously being carried out into technical education than is generally realized. However, the research position is scrappy and disjointed, and the working party believes that the present investment rate is ahead of intelligent application. In particular, besides greater availability of statistics, in the institutional field the clearing services need overhauling to facilitate awareness of what is happening in cognate fields. The working party found great difficulty in discovering the annual investment in the development of research into technical education, but if the planning of research into specialized training within industry is to be absorbed into the prime costs of industry and marketing, it suggests that assistance is needed in four ways.

First, established posts are necessary in the centres of higher education in the faculties of arts, education or applied science. Secondly, research units need to be established in universities, colleges of advanced technology, and other institutions, with an independent budget, and headed by specialists who may or may not be members of the academic staff. Thirdly, there is room for specific enquiries in any establishment, industrial or academic, with the use of a research studentship or *ad hoc* grant. Fourthly, development might be promoted within the National Foundation for Educational Research of the existing division concerned with research and information on technical education.

All this needs manpower and suitable recruitment, and the spread of incentives are at the heart of the whole problem of launching large-scale projects into new territory. The working party particularly stresses the need for more specialized workers in educational psychology, statistical methods, and the design of educational experiments, economic analysis, and sociology. It lists the topics for research in five broad groups, but makes no attempt to indicate a desirable priority. The groups cover entry to technical education and training, methods of teaching and training; relation between technical education and industrial and commercial training; problems of a broad scope, such as forecasting needs for technical personnel, aspects of public examinations, economics of the technical education; and comparative studies of technical education.

Even the titles of the broad groups of projects listed in this report indicate the implication of such research in other fields of education. The working party considers the question whether the developing situation calls for national supervision by some body after the style of the Medical Research Council. It is firmly of the opinion that, whether or not such surveillance is desirable, existing organizations must accept the need for close co-operation and the pooling of information and must agree on some form of clearing-house facilities. The Ministry of Education and the Scottish Education Department, the Ministry of Labour, the National Foundation for Educational Research, the Scottish Council for Research in Education, the National Advisory Council on Education for Industry and Commerce, the British Association for Commercial and Industrial Education are all concerned in one way or another, and the universities, local education authorities and organizations of teachers also have interests to develop. All these in coming together should attempt some more formal and structural form of co-ordination.

The working party considers that the initiative in securing closer co-operation should be taken by the Government, and points out that the case for creating a national council or grants committee, with powers to handle funds, to consider the direction of policy and to report to the Privy Council through a Minister, would be stronger if considerable sums from the national exchequer became available for disbursal among institutions engaged with research projects. Such a step would not, however, remove the need for much closer co-operation generally; it reiterates that the lead in developing new work must be taken by the National Foundation, the universities, the technical teacher training colleges, industrial firms and associations, local education authorities, and associations of principals and teachers in technical colleges, regional advisory councils, and the technical colleges and teachers themselves. It sees hopeful signs in the creation of the intelligence and research organization of the Ministry of Education, and the increased support given to the National Foundation for Educational Research. Furthermore, it suggests that the universities through their Departments of Education may be able, in the next quinquennium, to direct more of their resources into problems of technical education and to encourage postgraduate research in this field. This is important in view of the great need for research workers, and the working party suggests that conditions for the award of academic qualifications as a result of educational research should be broadened to give postgraduate workers in this field an incentive comparable with that of postgraduate workers in scientific and technical research.

MODIFICATION OF THE WEATHER

THE great economic potential of successful weather control led the United States Congress in 1958 to ask the National Science Foundation to launch a full-scale investigation of this exciting field of modern meteorology. Within the Foundation, a Weather Modification Research Programme has been developed as an integral part of the more inclusive Programme on Atmospheric Sciences, which required funds amounting to 6,615,000 dollars during the fiscal year ending June, 1962. Of this sum, 1,340,000 dollars were set aside to support weather modification research under a system of grants and contracts from the Foundation to research groups at university, Government and other laboratories.

The one major technique in use for weather modification is only fifteen years old. This is 'cloud seeding', that is, the introduction, into a cloud, of material calculated to have an effect on the constituent cloud particles. Certain clouds and types of fog can be modified; and, under certain conditions, rainfall can be somewhat augmented and hail discouraged. The possibilities merit further careful investigation.

A summary of progress made in the United States National Weather Modification Programme up to 1962 appears in a report[1] issued by L. J. Haworth, director of the National Science Foundation. Work has been concentrated on basic studies into the nature of cloud phenomena, on the study of known cloud-seeding methods, and on the investigation of other methods of local modification of clouds. The last-mentioned investigation includes methods of changing ascending or descending air currents, or of